FUTURE ACADEMY

الفيزياء الثانى عشر متقدم

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المهندس : يوسف الظهير

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In physics, we **use units to measure different physical quantities**.
Length is measured in meters (m).
Time is measured in seconds (s).

1, What is the unit of **work**?

2, What is the unit of **force**?

3, What is the unit of **density**?

SI Base Units

Quantity	Name	Symbol
Length	Meter	m
Mass	Kilogram	kg
Time	Second	s
Electric current	Ampere	a
Temperature	Kelvin	k
Amount of substance	Mole	mol
Luminous intensity	Candela	cd

When **measuring the distance between cities**, **using meters is impractical because the number would be too large**.
Therefore, we **use prefixes to simplify and scale values for easier handling**

Prefix	Symbol	Multiplier	Scientific Notation
Tera	T	1,000,000,000,000	10^{12}
Giga	G	1,000,000,000	10^{9}
Mega	M	1,000,000	10^{6}
Kilo	k	1,000	10^{3}
Hecto	h	100	10^{2}
Deca	da	10	10^{1}
Base	–	1	10^{0}
Deci	d	0.1	10^{-1}
Centi	c	0.01	10^{-2}
Milli	m	0.001	10^{-3}
Micro	μ	0.000001	10^{-6}
Nano	n	0.000000001	10^{-9}
Pico	p	0.000000000001	10^{-12}

Note: **The numerical value** represents the **relationship between the base unit and the new unit**

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4. How many meters are in $3000\ \mu m$?
5. How many millimeters are 3 kilometers?
6. How many megameters are in $200\ nm$?

Types of Quantities in Physics

Vectors

Vector Quantities (e.g., force, acceleration) have both magnitude and direction

scalers

Scalar Quantities (e.g., distance, mass) have magnitude only

Some scalar quantities are always positive, such as **distance**.
Others can be positive or negative, such as **electric flux**

7. **Is work a scalar or a vector quantity? If scalar, can it be negative?**
8. **What is the counterclockwise angle of a force vector from the positive x-axis if the force is directed west?**
9. **What is the counterclockwise angle from the x-axis if the force is directed south?**

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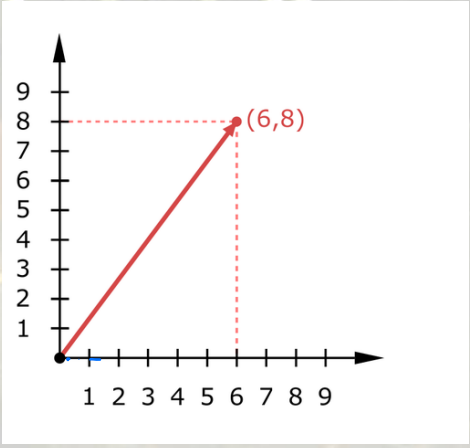
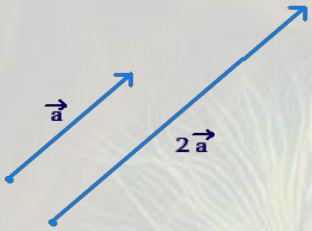
Vectors can be one-dimensional or multi-dimensional

A **body might move along the x-axis only**.
Another may move in both x and y directions simultaneously



Multiplying a vector by a positive scalar results in a **vector in the same direction but with different magnitudes**.



Multiplying a vector by a negative scalar result in a **vector in the opposite direction**

Note: To **find the opposite direction of a vector**, **add or subtract 180° from the original angle**

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10, A force of 5 N acts north. What is the new magnitude and direction if multiplied by 3?

11, A force of 5 N acts west. What is the result when multiplied by -10?

12, A force of 14 N acts at 30° from the positive x-axis. What is the result when multiplied by -3?

To find the magnitude of a vector, use the formula:

$$\text{Magnitude} = \sqrt{x^2 + y^2} \quad \text{(for 2D vectors)}$$

$$\text{Magnitude} = \sqrt{x^2 + y^2 + z^2} \quad \text{(for 3D vectors)}$$

To find the direction of a given vector use the formula:

$$\theta = \tan^{-1}\left(\frac{y}{x}\right)$$

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Case 1: If both x-component and y-component are positive, use the value directly.

Case 2: If both x-component and y-component are negative, you must add 180°.

Case 3: If the x-component is negative and the y-component is positive, you must add 180°.

Case 4: If the x-component is positive and the y-component is negative, you can either use the angle directly, or add 360° to get a positive angle.

13 If a vector has **x-component = 2** and **y-component = -3** **find its magnitude and direction from the positive x-axis.**

Two ways to multiply vectors

Dot Product

Cross Product

Results in a scalar

$$\mathbf{a} = \langle a_1, a_2, a_3 \rangle \quad \mathbf{b} = \langle b_1, b_2, b_3 \rangle$$

$$\mathbf{a} \cdot \mathbf{b} = a_1 b_1 + a_2 b_2 + a_3 b_3$$

Results in a vector that is perpendicular to the original vectors

$$\vec{a} \times \vec{b} = |\vec{a}|\,|\vec{b}| \sin\theta\, \hat{n}$$

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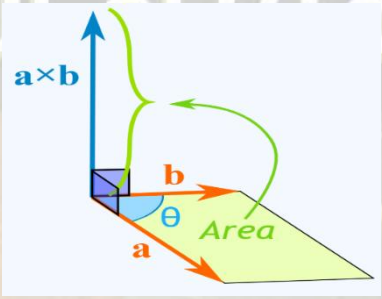
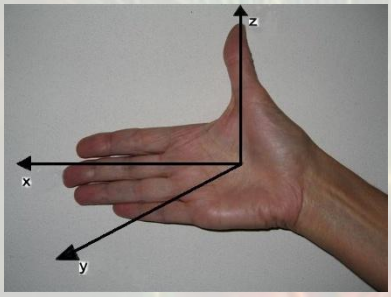
$$a \cdot b = |a||b| \cos\theta$$



For both, the **angle θ** is the **angle between the two vectors**

Right-hand rule can be used to determine the direction of the resulting vector



Adding Vectors

To add vectors, we need to add their components

$$\vec{C} = \vec{A} + \vec{B}$$

Given the **magnitude and angle**, **use trigonometric identities to find the x and y components**

$$A_x = A\cos\theta$$

$$A_y = A\sin\theta.$$

$$C_x = A_x + B_x$$

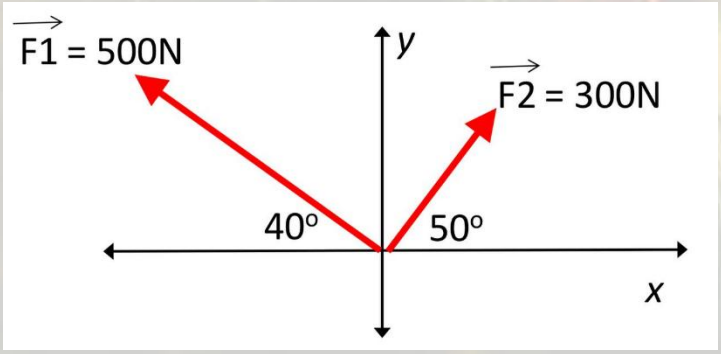
$$C_y = A_y + B_y$$

$$C_z = A_z + B_z.$$

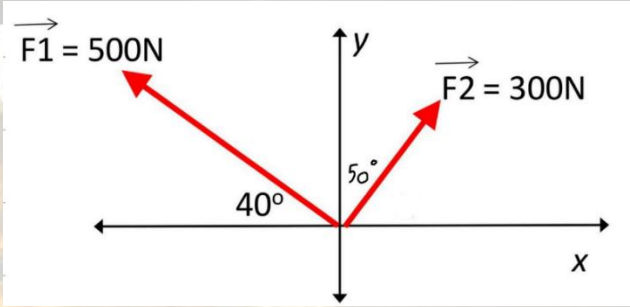
After adding the components, c**alculate the resultant vector's magnitude and direction** using the formulas explained above above

Note: If the **given angle is with respect to the y-axis**, **reverse the component formulas accordingly**

14, Find the resultant vector from the diagram shown



15, Find the resultant vector from the other diagram



Gravitational Force

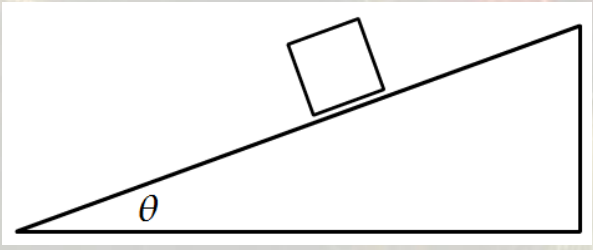
All objects on Earth experience **gravitational force**, always directed **downward**

Gravitational force is **directly proportional** to the **object's mass**

$$Fg = m \cdot g$$

15, What is the gravitational force acting on a 5 kg object

On an **inclined plane**, the **total gravitational force doesn't change**, but the component causing the object to **slide** depends on the angle of the slope



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16, A 3 kg object is at the top of a 30° incline. What is the total gravitational force? What is the acceleration of the moving object.

17, Compare the final speed with the object's **final speed** if it falls freely from the same height

Free Fall and Projectile Motion

You won't need projectile motion formulas from Grade 12 if you understand the concepts and basic motion equations.

Kinematics

$$v_f = v_o + at \qquad \Delta x = v_o t + \frac{1}{2}at^2$$

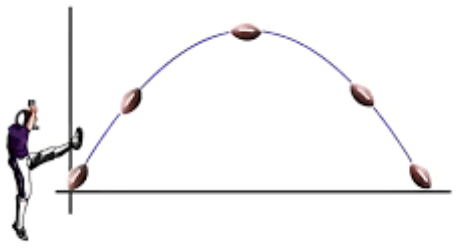
$$\Delta x = \frac{(v_f + v_o)}{2}t \qquad v_f^2 = v_o^2 + 2a\Delta x$$

In free fall, the acceleration is equal to gravitational acceleration

In **projectile motion**, the **object moves in both horizontal and vertical directions**

The **horizontal velocity** remains **constant** (acceleration = 0)

The **vertical velocity** changes due to gravity



18, An **object is launched at 30 m/s at a 45° angle** **Find its velocity (magnitude and direction) after 5 seconds**

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Relations in Physics

If an **object is moving at a certain speed**, we can calculate its **kinetic energy** using the following equation

$$\frac{1}{2}mv^2$$

The equation above indicates that the **kinetic energy of an object increases as its speed increases** and decreases as its speed decreases. This type of relationship is called a **direct relationship**.

Kinetic energy is directly proportional to the **square of the velocity**, meaning that if the **speed doubles**, the **kinetic energy increases by a factor of four.**

The **mass** in the kinetic energy equation is an **independent factor** that depends only on the moving object.